Oil Field Chemical Measurement Using Fluorescence Measurement Technology

Enviro-Tech Services

Advanced Sensor EX-1000 Chemical Detection

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Abstract

This technical paper provides the testing procedures used to evaluate the Advanced Sensors EX-1000's ability to measure commonly used chemicals in the oil and gas industry. The EX-1000 was connected, in-line with a flowing dynamic, therefore, simulating its ability to detect chemical leakage from an existent open loop heat exchanger in a customers facility. The study results demonstrate the EX-1000 is fully capable of monitoring such a process.

The OIW-EX Series of Oil in Water Monitor Systems uses laser radiation to energise the contents of the measurement chamber with an incident optical wavelength. A sensitive tuned detector at a different wavelength is then used to measure the stimulated fluorescence value. This fluorescence value is used to determine the proportion of chemical compounds within the chamber.

Introduction:

Due to complexity and efficiency, our customer wanted to use an open loop Heat Exchanger as opposed to closed loop system. However, the customer was very concerned and needed a guarantee that any leak could be detected down to very low levels, and that a system had the ability to shutdown and close off a discharge. Zero maintenance or intervention was extremely important. The customer had real concerns; Enviro-Tech and Advanced Sensors were requested to find a solution to their problem.

This report provides the testing procedures used to evaluate the EX-1000's ability to detect AI's and LDHL's. Enviro-Tech Systems (ETS) supplied the equipment, design, and operation in accordance with the parameters set forth in the customer's specifications. The customer supplied chemicals from two major chemical vendors to be tested. All testing took place at Enviro-tech's facility and laboratory located in Covington, LA, under the management of ETS personnel.

The remainder of this paper will illustrate the Advanced Sensors model EX-1000 proficiency in chemical detection, demonstrating the results from laboratory testing of static samples, and real-time flowing applications. Also, environmental regulations and disadvantages of discharge of these chemicals, into the environment, will be discussed demonstrating a genuine need for chemical detection in the oil and gas industry.

Chemicals used:

The customer specified all chemicals to be tested. Table A-1 and A-2 list specific information taken from the Material Safely Data Sheets (MSDS) provided by both chemical companies which are distinguished by the title Chemical Company A and B. Further, the numbers 1 and 2 will differentiate both hydrate inhibitors provide by each chemical company. The first column demonstrates the application or product use, and the second column gives composition of the chemicals as disclosed by the MSDS.

In order for a substance to be measured, the instrument must first be calibrated to read the sample. Calibration curves for each chemical were created, in the lab, using a removable 200ml static calibration chamber fitted to the Analyzer. Then, 20 µl of chemical was added to the 200ml chamber of water to create a 100 parts per million (ppm) sample of chemical mixed in water. A dilution of this 100ppm sample, by calculated amounts, yields the points for composing the calibration curve. Figure A-1, A-2, and A-3 show the fluorescence intensity of each chemical in a 100ppm sample. The figures represent the plotted calibration curves from each company's chemicals. Figure A-3 is a representation of all six chemicals plotted together on one graph. The graphs reveal that all chemicals did exhibit fluorescence and could potentially be measured.

Table A-1.

	Application & Number	Composition
Chemical Company A	Hydrate Inhibitor 1	Heavy aromatic Naphtha, Naphthalene, 1,2,4-Trimethylbenzene
	Hydrate Inhibitor 2	Methanol
	Asphaltene Inhibitor	Kerosene, Toluene, Naphthalene, Ethylbenzen

Table A-2

	Application & Number	Composition
Chemical Company B	Hydrate Inhibitor 1	2-Butoxyethanol Heavy aromatic Naphtha Quaternary Surfactant Naphthalene Glycerin
	Hydrate Inhibitor 2	Methanol Quaternary Surfactant Glycerin
	Asphaltene Inhibitor	Xylene, Isopropyl Alcohol Heavy aromatic naphtha Ethylbenzene Ionic Surfactants Naphthalene

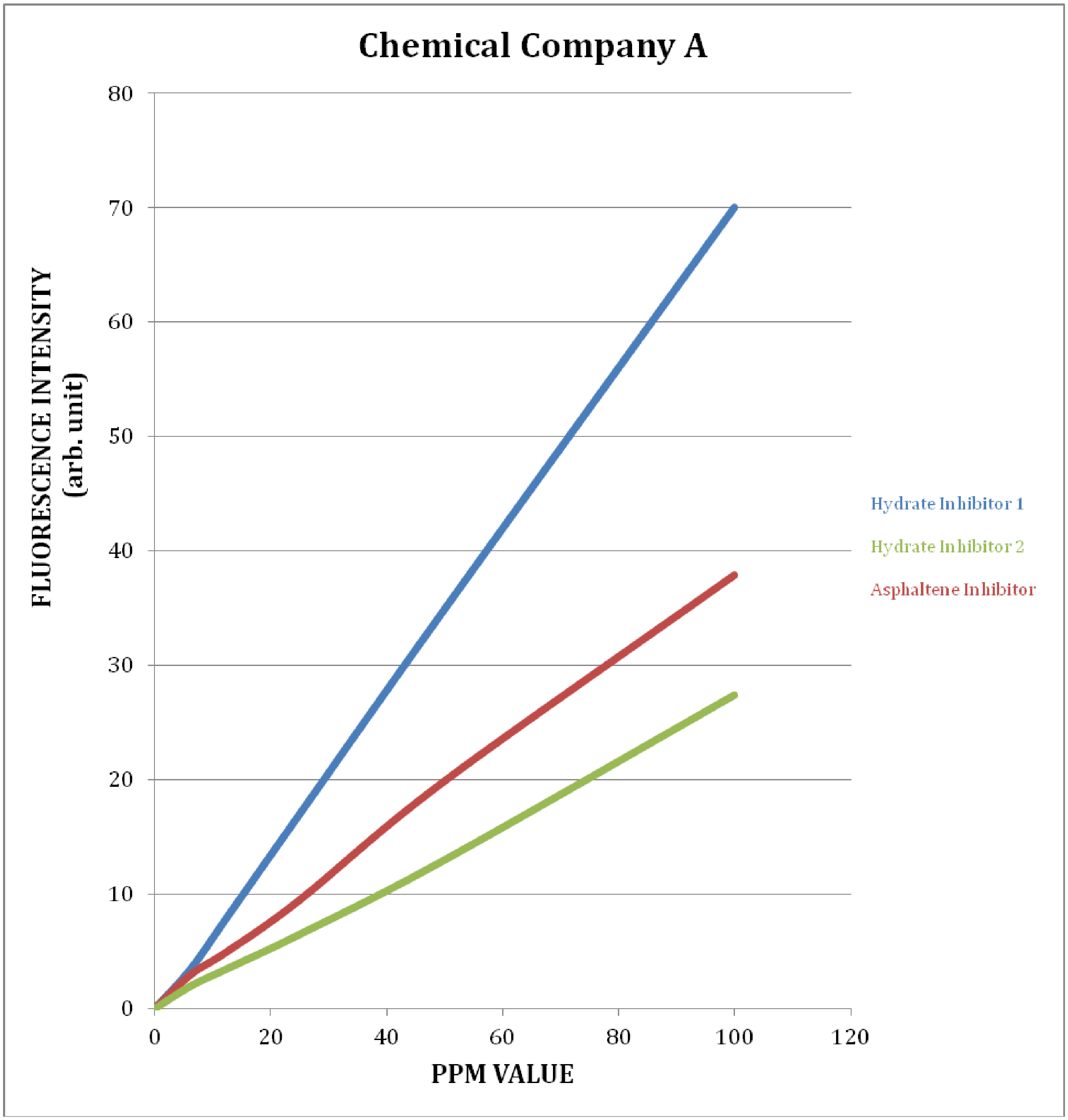

Figure A-1. Company A Calibration Curves Plotted

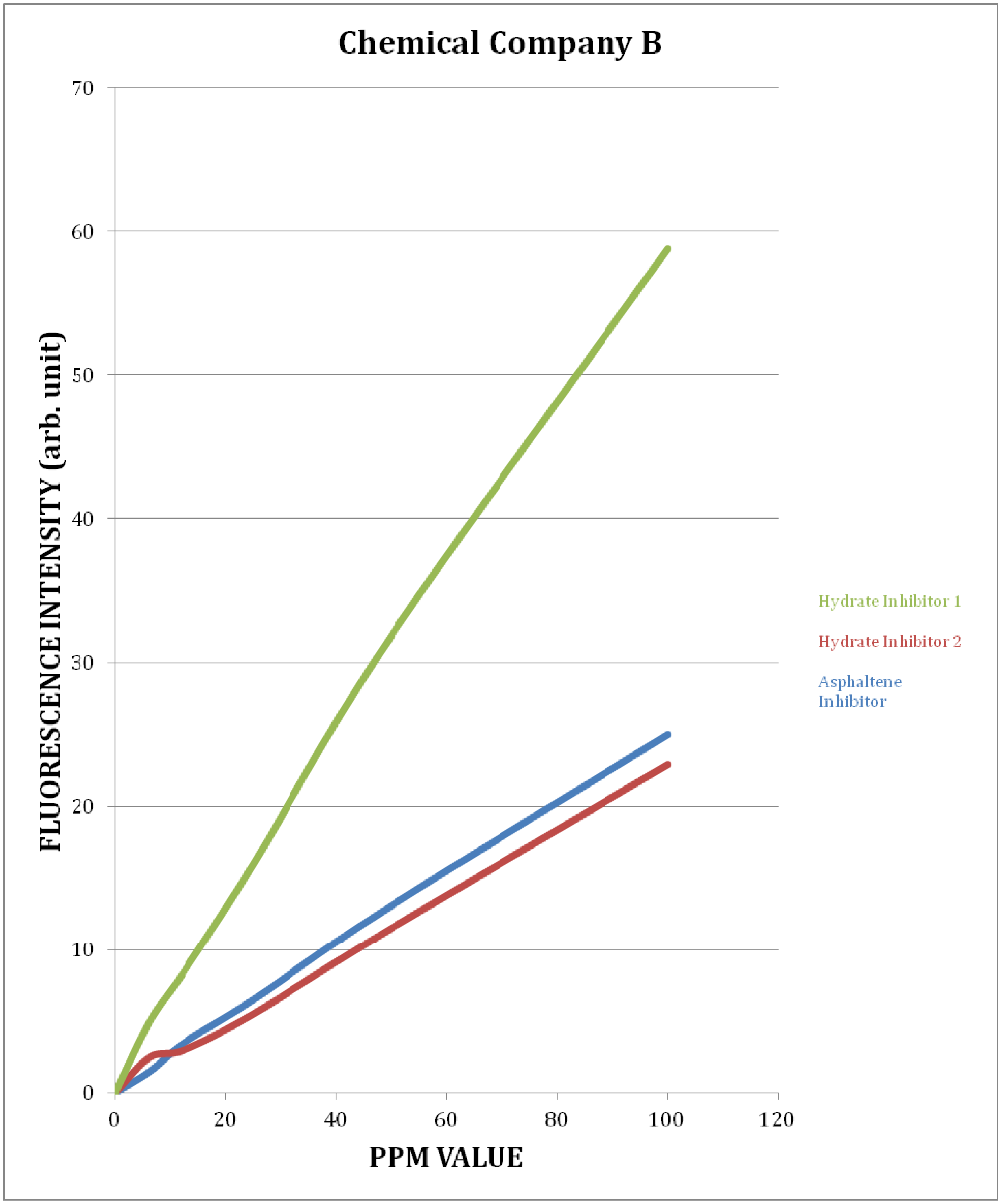

Figure A-2. Company B Calibration Curves Plotted

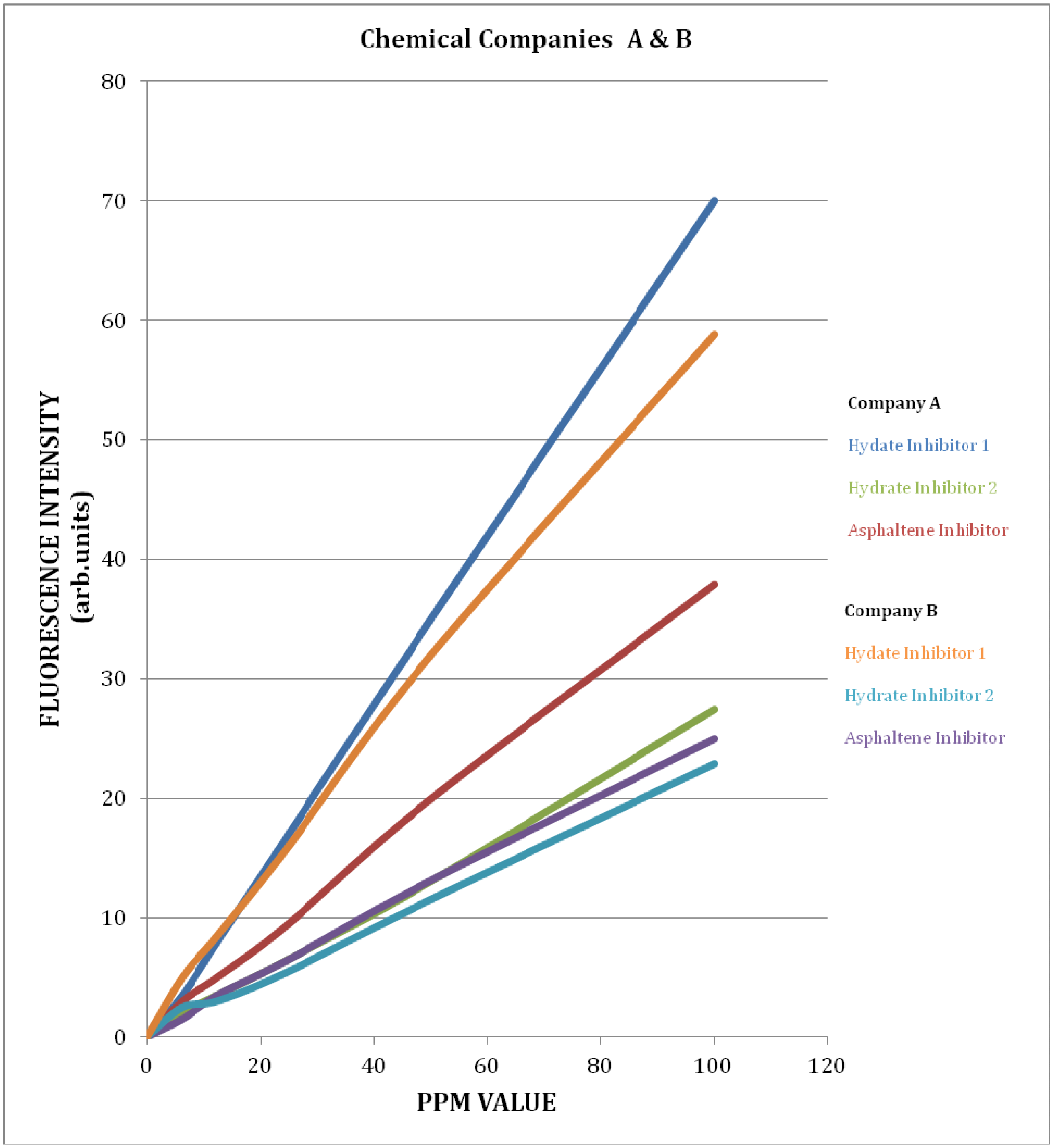

Figure A-3. Companies A & B Calibration Curves Plotted

Results: Static Testing

After determining the chemicals fluoresced, the first experiments were performed using a static sample of the chemical in water. Table B-1 and B-2 show the results of 100ppm chemical samples diluted until the resolution of the measurement eschewed. The results of the evaluation confirmed that the EX-1000 is able to detect and measure the specified chemicals accurately in this application.

Table B-1: Company A Static Testing

	Application	Composition	Dilution Results (ppm)
Chemical Company A	Hydrate Inhibitor 1	Heavy aromatic Naphtha, Naphthalene, 1,2,4-Trimethylbenzene	1.0ppm
	Hydrate Inhibitor 2	Methanol	6.0ppm
	Asphaltene Inhibitor	Kerosene, Toluene, Naphthalene, Ethylbenzen	2.0ppm

Table B-2: Company B Static Testing

	Application	Composition	Dilution Results (ppm)
Chemical Company B	Hydrate Inhibitor 1	2-Butoxyethanol Heavy aromatic Naphtha Quaternary Surfactant Naphthalene Glycerin	1.5ppm
	Hydrate Inhibitor 2	Methanol Quaternary Surfactant Glycerin	3.0ppm
	Asphaltene Inhibitor	Xylene, Isopropyl Alcohol Heavy aromatic naphtha Ethylbenzene Ionic Surfactants Naphthalene	2.0ppm

After verifying the chemicals could be detected, ETS applied this technique to a flowing application to provide further confidence that the analyzer could provide suitable leak protection in an actual field application.

Results: Flowing

Final testing aimed to design a system, which verified an EX-1000, could accurately detect a leak in a flowing application. This system consisted of a container with a spigot at the bottom, connected to a pump that fed the process through the analyzer inlet, which flowed into another container piped into the outlet of the analyzer. Placed directly after the pump, and before the analyzer, was a syringe pump. The injection rate and the flow rate of the pump were calculated to give us a known PPM sample flowing live through the system. Synthetic seawater at 110 ° F was mixed and tested, and a hydrometer was used to maintain the proper specific gravity. .

Each chemical was run through the flowing dynamic. Table B-1 and B-2 show the results from both companies, supplied chemicals, flowing through that system. The first column contains the known values of PPM entering the system; the three following columns contain the PPM levels displayed by the analyzer as each chemical was injected.

The Asphaltene Inhibitors, provided by both companies, produced inaccurate results in the flow analysis. They can be measured in a homogenized sample, as proved from the static tests, but the flow application posed problems. Problems of which we feel were due to the chemical properties of the Asphaltene. During testing, Asphaltene proved to be hydrophobic and highly adhesive. Installing a pump, in-line, upstream of the analyzer may produce enough turbulence to give a more accurate measurement of the Asphaltene Chemical, in the event of a leak.

Table B-1. Company A Results (Flowing)

	Chemicals	Hydrate Inhibitor 1	Hydrate Inhibitor 2	Asphaltene Inhibitor
Chemical Company A	Known PPM Values	Chemical (PPM)	Chemical (PPM)	Chemical (PPM)
	100	100	98	Not tested at this level
	50	50	46	0.5-7.5
	25	24.9	23	0
	12.5	12.1	11.5	0
	6.25	4	6	17 (Homogenized)
	3.125	Low resolution	3.5	0
	1.562	Low resolution	1.5	0

Table B-2. Company B Results (Flowing)

	Chemicals	Hydrate Inhibitor 1	Hydrate Inhibitor 2	Asphaltene Inhibitor
Chemical Company B	Known PPM Values	Chemical (PPM)	Chemical (PPM)	Chemical (PPM)
	100	90	99	0
	50	39	50-55	99.8 (homogenized)
	25	22.5	19	0
	12.5	12.5	10	0
	6.25	6-10	4.5	15-20 (homogenized)
	3.125	Low resolution	Low resolution	0
	1.562	Low resolution	Low resolution	0

Environmental Advantages

The oil and gas industry has a zero discharge policy. Seawater passes through an open loop heat exchanger to assure the chemicals within it, maintain a certain temperature range. There is no problem with chemical discharge in this application, unless the heat exchanger develops a leak. A leak would undoubtedly result in damage to the environment and aquatic life. Having the ability to measure chemicals accurately, and at low levels, can prevent leakage and alarm operators a repair is needed. With this ability, a company using an open loop heat exchanger on their production facility can be certain that they are following the standard, set by the industry, of zero discharge.

Conclusion

The Advanced Sensor EX1000 is capable of measuring both vendors' chemicals. The tests, and results have shown the analyzers effectiveness to detect and monitor the presence of the supplied AI's and LDHI's in various concentrations in a controlled test environment and under the condition of a simulated flow of seawater.